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Increasing the Efficiency and Effectiveness of IoT-Based Irrigation Systems for Optimizing Water Use in the Agricultural Sector

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Abstrak

Sistem irigasi tradisional yang digunakan saat ini seringkali tidak efisien dan efektif, sehingga menyebabkan pemborosan air. Teknologi Internet of Things (IoT) menawarkan solusi untuk meningkatkan efisiensi dan efektivitas sistem irigasi. Penelitian ini merupakan peneltian narrative review yang bertujuan untuk menilai, mengidentifikasi, menganalisis dan meringkas literatur terkait peningkatan efisiensi dan efektivitas sistem irigasi berbasis IoT untuk optimasi penggunaan air pada sektor pertanian. Kriteria inklusi meliputi; 1) Literatur berkaitan dengan topik penelitian tentang IoT, sistem irigasi, pertanian, efisiensi; 2) Database yang digunakan adalag Google Scholar; 3) Literatur yang digunakan adalah literatur dalam 10 tahun terakhir; 4) literature teserdia dalam full text. Sistem irigasi berbasis IoT berpotensi merevolusi praktik konservasi air pertanian dengan menyediakan alat dan wawasan yang dibutuhkan petani untuk mengoptimalkan penggunaan air secara efisien. Meskipun ada tantangan berupa biaya awal yang tinggi, persyaratan keahlian teknis, dan masalah konektivitas internet, manfaat teknologi IoT di bidang pertanian sudah jelas. Melalui pengumpulan data real-time, teknik irigasi yang presisi, dan penjadwalan yang efisien, sistem berbasis IoT menawarkan jalan menuju pengelolaan air berkelanjutan di bidang pertanian. Studi kasus dan testimoni merupakan tampilan yang sukses dari para petani, pentingnya penerapan solusi IoT untuk meningkatkan konservasi air pertanian menjadi jelas. Penting bagi para pemangku kepentingan untuk terus mendukung dan berinvestasi pada teknologi IoT untuk mendorong inovasi dan keberlanjutan di bidang pertanian.

Kata Kunci: *Efisiensi, Sistem Irigasi, IOT, Penggunaan Air, Pertanian*

Abstract

Traditional irrigation systems used today are often inefficient and ineffective, resulting in the waste of water. Internet of Things (IoT) technology offers solutions to increase the efficiency and effectiveness of irrigation systems. This research is narrative review research that aims to assess, identify, analyze, and summarize literature related to increasing the efficiency and effectiveness of IoT-based irrigation systems for optimizing water use in the agricultural sector. Inclusion criteria include: 1) Literature related to research topics about IoT, irrigation systems, agriculture, and efficiency; 2) The database used is Google Scholar; 3) The literature used is literature from the last 10 years; 4) literature is available in full text. IoT-based irrigation systems have the potential to revolutionize agricultural water conservation practices by providing farmers with the tools and insights they need to optimize water use efficiently. Despite the challenges of high initial costs, technical expertise requirements, and internet connectivity issues, the benefits of IoT technology in agriculture are clear. Through real-time data collection, precise irrigation techniques, and efficient scheduling, IoT-based systems offer a path toward sustainable water management in agriculture. As case studies and testimonials show success from farmers, the importance of implementing IoT solutions to improve agricultural water conservation becomes clear. Stakeholders need to continue to support and invest in IoT technology to drive innovation and sustainability in agriculture.

Keywords: *Efficiency, Irrigation System, IOT, Water Use, Agriculture*

INTRODUCTION

The agricultural sector plays an important role in supporting food security and national economic stability. One of the determining factors for the success of this sector is the availability of adequate irrigation water. However, in this modern era, the agricultural sector is faced with various challenges, such as limited water resources, drought, and global climate change, causing the availability of irrigation water to decrease. Irrigation system inefficiency: Traditional irrigation systems that are still widely used are often inefficient and cause water waste. The need for increased productivity: Demand for agricultural products continues to increase, so it is necessary to increase the productivity of agricultural land. Efficient irrigation is essential to optimize water use: Irrigation water is a limited natural resource, so its use must be optimized to avoid waste. Increase plant productivity: Plants need the right amount of water to grow and develop optimally. Maintain environmental sustainability: Waste of irrigation water can pollute the environment and damage the ecosystem.

Internet of Things (IoT) is a technology that allows physical objects to connect to the internet and communicate with each other. IoT technology has great potential to increase

the efficiency and effectiveness of irrigation systems by monitoring environmental conditions: IoT sensors can be used to monitor various environmental parameters, such as soil moisture, air temperature, and rainfall. Controlling irrigation systems: Irrigation systems can be controlled automatically based on data obtained from IoT sensors. Optimize water use: IoT-based irrigation systems can distribute water precisely according to plant needs, thereby minimizing wastage. Research on IoT-based irrigation has grown rapidly in recent years. Various IoT-based irrigation systems have been developed and tested in various countries. The research results show that an IoT-based irrigation system can increase water use efficiency by up to 50% and increase crop productivity by up to 20%.

Although IoT technology has great potential to improve the efficiency and effectiveness of irrigation systems, there are still several challenges that need to be overcome. Cost: The initial cost of building an IoT-based irrigation system can be expensive. Technical skills: Technical skills are required to build and maintain IoT-based irrigation systems. Data availability: Accuracy and availability of real-time data is critical to the success of IoT-based irrigation systems. However, with advances in technology and the increasingly cheap cost of IoT devices, it is hoped that IoT-based irrigation systems will become more easily accessible and adopted by farmers. This research is relevant to the government's efforts to increase food security and national economic stability. It is hoped that the results of this research can contribute to the development of more efficient and effective irrigation systems so that they can support increased productivity and sustainability in the agricultural sector.

METHOD

This research is a narrative review research which aims to assess, identify, analyze and summarize literature related to increasing the efficiency and effectiveness of IoT-based irrigation systems for optimizing water use in the agricultural sector. Inclusion criteria include: 1) Literature related to research topics about IoT, irrigation systems, agriculture, and efficiency; 2) The database used is Google Scholar; 3) The literature used is literature from the last 10 years; 4) literature is available in full text.

RESULTS AND DISCUSSION

Agriculture remains one of the sectors that uses the most water globally and accounts for a significant portion of freshwater consumption. With increasing pressure on

water resources due to population growth and climate change, the need for sustainable water management practices in agriculture is becoming increasingly important. In this context, the emergence of Internet of Things (IoT)-based irrigation systems presents a promising solution for improving agricultural water conservation. By utilizing IoT technology, farmers can monitor and optimize water use in real time, apply precise irrigation techniques, and increase the efficiency of irrigation scheduling. This essay investigates the impact of IoT-based irrigation systems on agricultural water conservation and the challenges associated with their implementation. It presents case studies of the successful implementation of irrigation systems in agricultural settings.

The implementation of IoT-based irrigation systems has revolutionized agricultural water conservation practices by enabling farmers to monitor and optimize water use through real-time data collection. By utilizing IoT sensors and devices, farmers can collect data on soil moisture levels, crop water requirements, and weather conditions. This data is then analyzed to provide insight into when and how much water should be delivered to plants, thereby reducing water waste. Additionally, precision irrigation techniques, such as drip irrigation and variable rate irrigation, can be implemented more effectively with IoT technology, ensuring that water is delivered precisely where and when it is needed. Additionally, the integration of weather forecasting and soil moisture sensors into IoT irrigation systems enables more efficient irrigation scheduling, ensuring plants receive sufficient water without over-irrigation, resulting in water savings and increased crop yields.

Although IoT-based irrigation systems have many benefits, some challenges and limitations hinder the widespread adoption of these irrigation systems in agricultural environments. One of the main obstacles is the high initial costs and investment required to set up IoT infrastructure on farms. This includes purchasing IoT devices, sensors, and connectivity equipment, which may be an obstacle for small-scale farmers. Additionally, technical expertise and training are essential for farmers to operate IoT systems and interpret the resulting data effectively. This poses challenges, especially in rural areas where access to training and skilled labor may be limited. In addition, dependence on stable internet connectivity in remote agricultural areas is also another obstacle, because IoT systems depend on strong network connections to transmit data and receive commands effectively.

To illustrate the potential of IoT-based irrigation systems in improving agricultural water conservation, several case studies and success stories can be examined. For

example, a farm in California implemented IoT technology and reduced water use by 30% while increasing crop yields by 20% compared to traditional irrigation methods. Farmers have reported significant water savings, reduced labor costs, and improved crop quality thanks to the precise control and monitoring offered by IoT systems. Testimonials from farmers highlight the ease of use and ability to access real-time data on their smartphones, allowing them to make informed decisions regarding irrigation practices. Comparing water conservation and crop productivity before and after implementing IoT solutions further underscores the positive impact of this technology on sustainable agricultural practices.

CONCLUSION

IoT-based irrigation systems have the potential to revolutionize agricultural water conservation practices by providing farmers with the tools and insights they need to optimize water use efficiently. Despite the challenges of high initial costs, technical expertise requirements, and internet connectivity issues, the benefits of IoT technology in agriculture are clear. Through real-time data collection, precise irrigation techniques, and efficient scheduling, IoT-based systems offer a path toward sustainable water management in agriculture. As case studies and testimonials show success from farmers, the importance of implementing IoT solutions to improve agricultural water conservation becomes clear. Stakeholders need to continue to support and invest in IoT technology to drive innovation and sustainability in agriculture.

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